Space Weather Technical Forecast

Issued on Saturday, 23 December 2023 at 12:35 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as recorded by GOES16, has been Low throughout the past 24 hours, with only C-class flares observed. The X-ray trace generally showed a downward trend, eventually residing near the B/C flux boundary, but began to pick up late in the period with a peak C3.1 flare from AR3530 at 23/0914UTC.

There are now eight numbered sunspot regions on the Earth-facing side, with AR3519 now indistinct on the western limb, and with AR3524 having faded to plage in the north-centre disc. The main growth trends were seen in AR3528 and AR3530 in the period, with minor proliferation of central spots, but more significantly perhaps also now tenuous Mt Wilson deltas in both, at least in passing. Other regions were largely stable or else in areal decline, with the exception of AR3533 in the northeast which saw proliferation and spreading, albeit from a magnetically simple starting point.

HMIBC imagery is relatively starkly polarised at present, which is proving a fertile breeding ground for filaments on the boundaries of these areas, however the majority of these remain apparently well-anchored at the time of writing. The main exception to this was a large filament near 20 West that went through periods of disturbance. It is not yet clear from imagery as to whether any of these restive periods produced any Coronal Mass Ejections (CMEs), however this is the main source of monitoring.

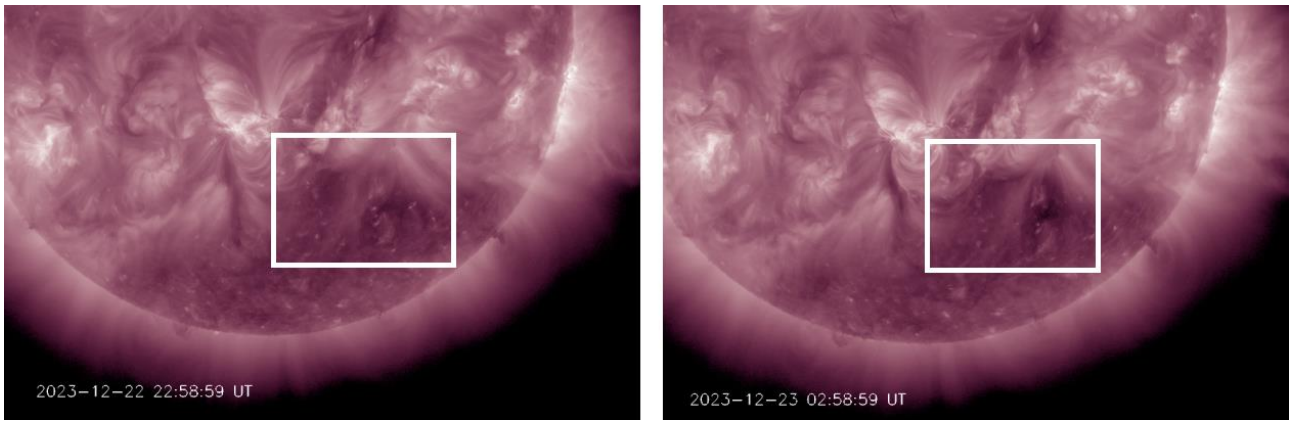

Figure 0: AIA211 imagery of possible coronal dimming immediately north of CH83/-, which was briefly 'occluded' by possible filx emergence to its north. This is the posited source of a narrow CME seen heading south on coronagraph imagery, with modelling results awaited.

A narrow CME was tentatively identified into the current UTC morning, seen heading apparently largely south of the Sun-Earth line on Lasco C2 and STEREO COR2. The source, while uncertain, could be a minor dimming immediately north of coronal hole 83 around the turn of the current UTC

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day (i.e. straddling 23/0001UTC), with the ejecta apparently then angled slightly east and down of its apparent emission source. This feature has been analysed and modelling results are awaited, although it appears too narrow to feature significantly. At the time of writing then, no definitively Earth-directed CMEs were in evidence.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, have been characterised by a slow solar wind regime in the past 24 hours. The solar wind speed was steady below 350km/s, with density near the long-term average in single figures ppcc. The IMF was at Background, at or below 8nT, with the north-south component ranging between +7 and -6nT. The phi angle was positive (away from the Sun) throughout.

The net result of the above solar wind measures was for resolutely Quiet geomagnetic activity.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background levels.

GOES16 high energy (greater than 2MeV) electron flux peaked at High levels before falling, with a peak of 1790pfu at 22/1525 UTC. The 24-hour fluence tracked mostly level just below the Active threshold (1e8 integrated pfu) before a recent slight fall. Fluence at at 23/0001UTC was 8.72e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity is forecast, with a chance of Moderate activity. A slight reduction is forecast from 24 December as AR3519, the most active region, rotates off the visible disc.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are forecast. Solar wind speeds are expected to remain at Background levels in the absence of coronal hole high speed streams or significant CME arrivals. Geomagnetic activity is expected to remain largely Quiet.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is at background levels and expected to remain at similar levels. There is a Slight Chance of solar radiation storms, should there be any larger flares on the western side of the disc.

High energy electron flux is expected to show a gradual decline from current diurnally high levels, with a falling Slight Chance of Active 24-hour integrated fluence.

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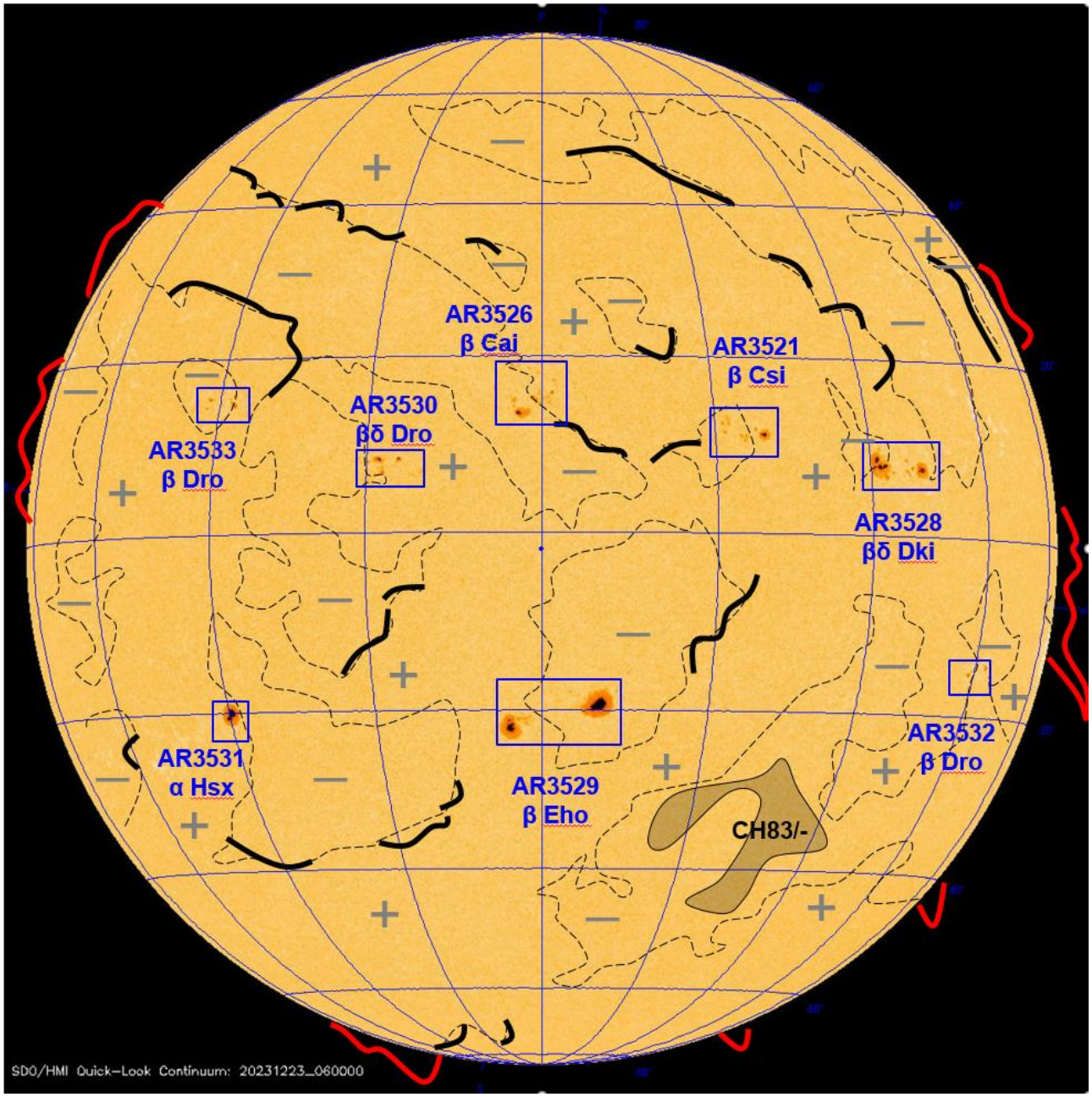
Figure 1. Solar Analysis Valid 23/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are forecast through the next four days.

A high speed stream from coronal hole 83 was tentatively forecast to connect with Earth on 22 December but this is now overdue and perhaps lies too far south of the ecliptic to feature. No further coronal holes are expected through the remainder of the forecast period.

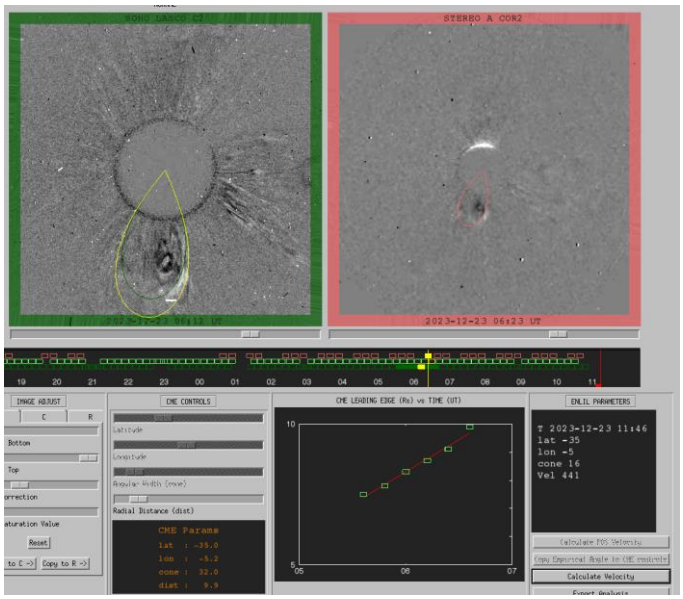
Geomagnetic activity is forecast to be mainly Quiet throughout the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: CAT tool analysis of the southwest quadrant dimming starddling the turn of the current UTC day. Modelling results using these parameters are awaited in Enlil.



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Radio Blackouts - X-Ray Flares:

There are now eight numbered sunspot regions on the disc, with the recent most active AR3519 now lying beyond analysis on the western limb. The passing of this region should lead to a step-wise decrease in the risk of X-ray flares by 24 December. Contributions to activity from other sunspot regions on the disc are perhaps surprisingly scant in recent hours - this despite numerous Zurich D-groups and perhaps even Mt Wilson deltas. Current Low activity is perhaps a fragile state of affairs.

Far-side soundings, EUV flux imagery of the eastern limb and expected returning Carrington locations for numerous sunspot regions all suggest a slight increase in population on the front-side is due, with soundings in particular suggesting returns in both the northern and southern solar hemispheres by Christmas, although there has been little evidence of much in the way of activity from this location, with coronagraphs relatively quiet.

Probabilities of flares therefore fall slightly in the near-term, to a new lower daily Chance of M-class, to be reviewed as and when new regions present for analysis.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	40	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Past three days to 23/1200UTC of PROBA2 C-class flare detections and above, courtesy of SIDC ROB. Note the dominance of off-going AR3519 in the lower right.

Solar Radiation Storms - (High Energy Protons):

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The high energy (greater than 10MeV) proton flux observed by GOES16 is at Background levels and is most likely to remain at similar levels.

There is a Slight Chance of minor solar radiation storms throughout, initially from AR3519, and then from a well-spaced succession of nominally slightly complex Zurich D- and E-groups tracking ever-westwards on the facing side. The result is a relatively constant risk for all days of the period.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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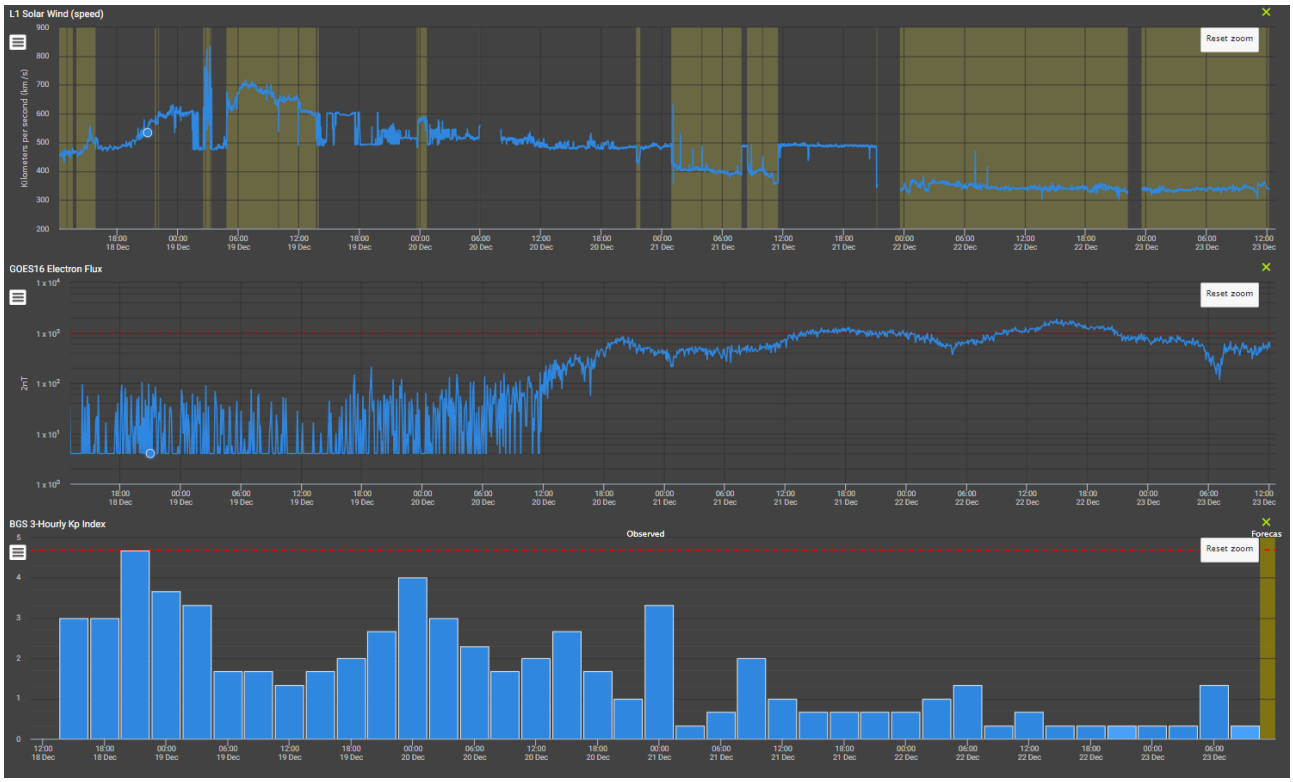
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) peaked at High in response to coronal hole 82's fast wind, however it has shown a recent slight attenuation at GEO that is now unlikely to be replenished given that there are no further inputs expected. A steady decay in electron flux values at GEO is instead now expected.

MOSWOC REFM and persistence both suggest current levels should ebb in the four-day period, and this is accepted as good guidance, with the main uncertainty being the rate at which this occurs.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	10	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Some solar wind measures since 18/1200UTC: specifically L1 solar wind (top, ACE shaded yellow); GOES16 high energy electron flux (middle); and BGS 3-hourly Kp index. Note the reaction in flux to CH82's fast wind, the subsequent stabilising in the absence of geomagnetic activity, and the apparently now beginning slow waning of GEO flux levels.



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